WHAT IS CLAIMED IS:

1. A method comprising:

providing a fuel cell system including a fuel reforming reactor and at least one blower for selectively conveying combustion gas through a heating side of the reforming reactor at different mass flow rates;

starting-up the reforming reactor by heating a reforming side of the reactor with a combustion gas flowing through the heating side of the reactor; and then

operating the reactor to produce a reformate stream by driving an endothermic reforming reaction on the reforming side with heat from a combustion gas flowing through the heating side;

wherein a mass flow rate of combustion gas through the heating side during the starting-up is at least about five times a mass flow rate of combustion gas through the heating side during the operating.

2. The method of claim 1 wherein the pressure drop across the heating side of the reforming reactor during the starting up is less than about 10 inches of water.

3. The method of claim 2 wherein the system includes a vaporizer having a heating side downstream from the heating side of the reforming reactor, and the combined pressure drop across the heating side of the vaporizer and the heating side of the reforming reactor during the starting-up is less than about 10 inches of water.

4. The method of claim 2 wherein a Reynolds number of the combustion gas flowing through the heating side during the starting up is less than about 2000.

5. The method of claim 1 wherein the combustion gas flows through the heating side of the reactor from a first face of the reactor to a second face of the reactor, wherein the first and second faces each have a length and width substantially greater than the distance between the faces.

6. The method of claim 5 wherein the system includes a vaporizer having a heating side downstream from the heating side of the reforming reactor, the vaporizer including a first face and a second face each having a length and width substantially greater than the distance between the faces, the method further comprising flowing the combustion gas through the heating side of the vaporizer from the first face of the vaporizer to the second face of the vaporizer.

7. The method of claim 6 wherein there is no intervening heat exchanger between the heating sides of the reforming reactor and the vaporizer.

8. The method of claim 1 wherein there are at least two blowers.

9. The method of claim 1 wherein the starting up includes raising an internal temperature of the reforming side from below about 50° C to above about 400°C while the at least one blower consumes an amount of power less than about 4% of the stead state electrical output of the fuel cell system.

10. A method comprising:

starting up a fuel reformer by heating the endothermic reaction channels of the fuel reformer with hot gas flowing through heating channels at a mass flow rate sufficient to raise the internal temperature of the channels from a starting temperature to an elevated operating temperature in less than about 30 seconds;

wherein the starting temperature is less than about 50°C and the elevated operating temperature is above about 600°C.

11. The method of claim 10 wherein the fuel reformer is coupled to a fuel cell, and the hot gas flows under pressure of at least one electric blower wherein the total consumption of electrical power by the at least one blower during the heating is less than about 8% of the maximum steady state electrical power output from the fuel cell.

12. The method of claim 10 further comprising:

after the heating, operating the fuel reformer at the elevated operating temperature with heat supplied by the hot gas to produce a reformate stream;

wherein a mass flow rate of hot gas through the heating side during the starting-up is at least about three times a mass flow rate of combustion gas through the heating side during the operating.

13 The method of claim 10, 11 or 12 wherein the fuel reformer is a steam reformer.

14. The method of claim 13 wherein a mass flow rate of hot gas through the heating side during the starting-up is at least about five times a mass flow rate of combustion gas through the heating side during the operating.

15. The method of claim 13 further comprising atomizing liquid fuel into superheated steam to produce a vapor inlet stream to the steam reformer.

16. The method of claim 10 wherein the hot gas is a combustion exhaust.

17. The method of claim 10 wherein the reformer defines a first and second face each having a length and a width substantially greater than the distance between the faces, and wherein the heating channels are flow paths between the faces.

18. A system comprising:

a fuel cell;

a steam reformer operable to produce hydrogen for use by the fuel cell from steam and hydrocarbons; and

a vaporizer for supplying the steam to the steam reformer;

wherein the steam reformer is a panel defining a first face and a second face wherein the length and width of each face is substantially greater than the distance between the faces.

19. The system of claim 18 further comprising a multiplicity of reformer heating channels from the first face to the second face of the steam reformer wherein the smallest dimension of the heating channels is less than about 0.05 inch.

20. The system of claim 19 wherein the vaporizer is a panel defining a first face and a second face and having a multiplicity of vaporizer heating channels therethrough, wherein the vaporizer heating channels are downstream from the reformer heating channels.

21. The system of claim 20 further comprising variable speed blower means for conveying hot gas through the reformer and vaporizer heating channels at different flow rates during system start up and system operation.

22. A system comprising:

a fuel cell;

a steam reformer for converting a gaseous inlet steam to a reformate outlet stream for use by the fuel cell;

a vaporizer for providing superheated steam and having a heating side downstream from a heating side of the steam reformer, and

a fuel injector between the vaporizer and the reformer for injecting a liquid fuel into the superheated steam to produce the gaseous inlet stream to the reformer.

23. The system of claim 22 further comprising at least one blower and a controller, wherein the controller is operable to selectively cause the at least one blower to convey a hot gas through the heating sides at substantially different mass flow rates during a start up phase and an operating phase of the system.

24. The system of claim 22 or 23 wherein there is no intervening heat exchanger between the heating sides of the steam reformer and the vaporizer.

25. The system of claim 24 wherein at least one of the vaporizer and the steam reformer define an inlet face defining inlets to heating side flow paths and an outlet face defining outlets to the heating side flow paths wherein each of the faces have a length and width substantially greater than the distance between the faces.

26. The system of claim 25 wherein the smallest dimension of the heating side flow paths is less than about 0.05 inch.

27. A system comprising:

a steam reformer having a reforming side and a heating side;

a water vaporizer having a vaporizing side upstream from the reforming side of the reformer and a heating side downstream from the heating side of the reformer; and

a fuel injector fluidly between the vaporizing side and the reforming side;

wherein the fuel injector is configured to atomize a liquid fuel into the superheated stream to produce a gaseous inlet stream to the reforming side during a fuel reforming operation; and

wherein at least one of the vaporizer and the steam reformer define an inlet face defining inlets to heating side flow paths and an outlet face defining outlets to the heating side flow paths wherein each of the faces have a length and width substantially greater than the distance between the faces.

28. The system of claim 27 further comprising a combustion gas conduit defining an interior surface for conveying a combustion gas into the heating side of the steam reformer, wherein a major portion of the interior surface adjacent the heating side of the steam reformer is substantially non-metallic.

29. The system of claim 27 further comprising a fuel cell downstream from the reforming side for producing power from hydrogen in a reformate outlet of the reforming side.

30. The system of claim 29 wherein the fuel cell powers a vehicle and the temperature of the steam reformer is operable to be raised during start-up from ambient to an elevated operating temperature in less than 30 seconds by flowing a hot gas through the heating side while consuming an amount of power less than about 4% of the maximum stead state electrical power output from the fuel cell.

31. An on-demand fuel reforming system comprising:

a steam reformer having a heating side;

a water vaporizer for producing steam for the steam reformer and having a heating side downstream from the heating side of the steam reformer; and

a combustion zone for supplying a hot gas to the heating side of the steam reformer;

wherein the heating sides of the steam reformer and of the vaporizer each include a multiplicity of flow paths between a pair of faces wherein the length and width of each of the faces is substantially greater than the distance between the faces.

32. The system of claim 31 further comprising a fuel injector operable to introduce a liquid fuel into superheated steam from the vaporizer to produce the inlet stream to the steam reformer.

33. The system of claim 31 further comprising a controller operable to vary the flow rate of the hot gas and the steam to carbon ratio of an inlet to the reformer depending on whether the system is being started up or in steady state operation.

34. The system of claim 33 wherein the controller is operable to have the temperature of the hot gas at the first face of the reformer at least 200°C greater than a metal temperature of the first face of the reformer.

35. The system of claim 34 wherein the temperature of the hot gas at the first face of the reactor during steady state operation is greater than the maximum operating temperature for the material of construction of the reformer.

36. The method of claim 1 or 12 wherein the S:C ratio during the starting-up is at least about 4 times greater than during the operating.

37. The method of claim 36 wherein the S:C ratio during the starting-up is at least 8 times greater than during the operating.

38. The method of claim 5, wherein the temperature of the hot gas at the first face of the reactor is at least 200°C greater than the temperature of the first face of the reactor during the operating.

39. The method of claim 1 further comprising conducting heat through the reactor away from an inlet to the heating side of the reactor to prevent the metal temperature at the inlet from exceeding a maximum operating temperature when the hot gas at the inlet is at least about 200° above the maximum operating temperature.

40. A fluid processing device comprising:

a stack of thin sheets integrally bonded, the stack including alternating recessed sheets having aligned header openings at opposing ends, wherein the recesses in the sheets define a plurality of first microchannel flow paths between the header openings and a plurality of second flow paths distinct from the first flow paths;

wherein the aligned header openings are high aspect ratio in shape and the cumulative cross sectional area of the flow in an entrance region to one of the first microchannel flow path is within about 20% of the cross sectional area of the flow in the first flow path a substantial distance removed from the entrance region.

41. The fluid processing device of claim 40 wherein the aligned header openings have a major axis that is generally parallel with a line connecting the openings at the opposing ends of the sheets.

42. The fluid processing device of claim 40 wherein the header openings have a shape that generally defines at least three sides wherein two sides are substantially longer than a third side and wherein the two longer sides are relatively adjacent the first flow paths and the shorter side is relatively spaced from the first flow paths.

43. The fluid processing device of claim 42 wherein the header openings are triangular.

44. The fluid processing device of claim 40 wherein the aspect ratio of the header openings is at least about 2:1.

45. The fluid processing device of claim 40 wherein the cumulative cross sectional area of the flow in the entrance region is within about 10% of the cross sectional area of the flow a substantial distance removed from the entrance region.

46. The fluid processing device of claim 40 wherein the device is a laminar flow heat exchange capable of greater than 80% effectiveness between two equi-molar flows of air at 1atm pressure where the pressure drop in each air stream is less than about 2.5 inches of water.

47. A fluid processing device comprising:

a stack of thin sheets integrally bonded, the stack including alternating recessed sheets having aligned header openings at opposing ends, wherein the recesses in the sheets define a plurality of first microchannel flow paths between first ones of the header openings and a plurality of second microchannel flow paths between other ones of the header openings;

wherein the aligned header openings are high aspect ratio in shape and the cumulative cross sectional area of the flow in an entrance region to one of the first microchannel flow path is within about 50% of the cross sectional area of the flow in the first flow path a substantial distance removed from the entrance region.

48. A device for mixing a first fluid stream with a second fluid stream comprising:

a stack of thin sheets integrally bonded, the stack including alternating recessed sheets wherein the recesses in the sheets define at least a portion of a multiplicity of first flow paths for conveying the first fluid to an outlet face of the stack and a multiplicity of second flow paths for conveying the second fluid to the outlet face of the stack, the sheets further including at least one set of aligned header holes for distributing the first fluid to the first flow paths;

wherein the first and second flow paths are in thermal contact while in the stack;

wherein outlets of the first flow paths are interleaved with outlets of the second flow paths such that the first and second fluids mix upon exiting their respective flow paths.

49. The mixing device of claim 48 wherein at least one of the first and second flow paths have at least one dimension less than about .05inch.

50. The mixing device of claim 48 wherein the multiplicity of second flow paths have inlets on an inlet face of the stack that is opposite the outlet face of the stack.

51. The mixing device of claim 50 wherein the inlet and outlet faces of the stack each have a length and width substantially greater than the distance between the faces.

52. The mixing device of claim 51 wherein the multiplicity of second flow paths have a length about equal to the distance between the faces.

53. The mixing device of claim 48 wherein there are at least 10 first flow paths and at least 10 second flow paths